

SPRING DISK CLAMP UTILIZING WEDGED RETAINING RING

CROSS REFERENCE TO RELATED APPLICATIONS

Priority is claimed from U.S. Provisional Patent Application No. 60/217,995 filed on
5 July 13, 2000, and entitled "SPRING DISK CLAMP UTILIZING WEDGED RETAINING
RING" and further identified as Attorney Docket No. 3123-366-PROV, the disclosure of
which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

10 This invention relates to disk drive systems, and more particularly, to an apparatus
and method of securing one or more data storage disks to a hub of a spindle motor used in
a disk drive.

BACKGROUND OF THE INVENTION

15 Disk drive data storage systems typically include one or more data storage disks
mounted to a spindle hub, and a spindle motor drives the spindle hub which rotates the disks
at high RPMs. A disk clamp assembly secures the disks to the hub.

Data disks have a central bore or opening that receives the spindle hub. A common
type of disk clamp assembly includes an annular or disk-shaped disk clamp, and a number
20 of screws that secure the clamp to the hub. One or more disks positioned below the clamp
are secured to the hub. In addition, spacers may be placed on both sides of each disk. For
example, in a disk drive with a single data disk, the arrangement could include in series, a
clamp, a spacer adjacent the clamp, a disk, a spacer on the opposite side of the disk, and then

the hub. For some disk clamp assemblies, a top data disk may directly contact the disk clamp without the use of a spacer. The disks and spacers are often referred to as a disk pack.

Examples of references disclosing clamps utilizing securing screws include the U.S. Patent Nos. 5,274,517; 5,333,080, 5,528,434, and 5,790,345.

5 Certain disadvantages arise by using screws to secure the clamp to the hub. One distinct disadvantage is that the screws transmit uneven and irregular radially and axially directed forces to the data disk, thus resulting in surface irregularities on the disk. Any distortion or surface irregularities of the disk read/write surface may result in poor head transducer flight characteristics. Another disadvantage is that use of screws contributes to
10 disk contamination. Particle generation occurs when the screws are driven for attaching the clamp.

Another type of disk clamp exists which does not require the use of screws to secure the clamp to the hub. Presumably, these types of clamps help to reduce undesirable radial or axial loading and also help to reduce contamination. One example of a clamping device
15 which does not require the use of screws to secure a clamp to the hub includes the device disclosed in the U.S. Patent No. 5,270,999. The disk clamp disclosed in this references has a flat lower surface which directly contacts the data disk. The central opening of the clamp includes an inner conical surface. The upper end of the hub includes a groove having a complementary conical surface. When the clamp is mounted over the hub, a uniform
20 circumferential gap exists between the conical surfaces. A clip or spring is placed in the gap between the conical surfaces. When the spring is in place, the clamp resists axial force that may act to disengage the disk from the hub. In addition to the clip or spring, an O-ring is

also used to stabilize the disk with respect to the hub. The clamp disclosed in the '999 patent provides very little axial force to secure the disk or disks to the hub. Thus, the O-ring must be used to help prevent radial movement of the disk with respect to the hub. There is always some small gap between the inner edge of the disk defining the central opening and the outer 5 surface of the hub. This gap can allow radial movement of the disk with respect to the hub if no force is provided to prevent such radial movement.

While the foregoing references may be adequate for their intended purposes, the clamp of the present invention further simplifies the overall disk clamp and hub arrangement, thus minimizing the cost of fabrication and assembly, reducing the likelihood of malfunction 10 in the disk drive system, and providing effective and consistent performance.

SUMMARY OF THE INVENTION

In accordance with the preferred embodiment of the present invention, an apparatus in the form of a disk clamp, and a method for securing one or more data storage disks to a 15 hub of a disk drive is provided. The disk clamp eliminates the need for using screws to secure the clamp to the hub. In use, the clamp provides an axial force upon the disk pack which prevents the disk(s) from both axial and radial displacement with respect to the hub. The axial force keeps the disk or disks from slipping relative to the hub during rotation, and during events such as high shock loads impacting the disk drive. The disk clamp is deflected 20 by an external axial load, and then a retaining member such as a wire ring or multiple sections of wire arcs are inserted between an angled surface defining the central opening of the clamp and a corresponding sloping surface defining a concentric groove formed on the

hub. Since screws are not used to set the clamp, uneven loads causing undesirable radial and axial forces upon the disk or disks are eliminated, thus reducing disk distortion in the direction of read/write flight. Furthermore, O-rings or other stabilizing structures are not required to stabilize the connection between the disk and the hub because of the axial force
5 which is provided by the clamp.

The disk clamp includes a lower peripheral flange which contacts the underlying spacer or disk. When the external axial load is applied to set the clamp, the disk clamp itself acts as a spring in that it deflects downward in response to the applied axial load. After the retaining member is placed in the gap between the groove on the hub and the angled surface
10 of the clamp, the axial load is removed which enables the disk clamp to spring back to its undeflected state; however, the retaining member prevents full return resulting in the retaining member being wedged between the clamp and the hub. A peripheral groove may be formed on the upper surface of the clamp for receiving a balance ring. The balance ring is sized and positioned to spin balance the disk pack.

15 Additional advantages will become apparent from a review of the below-described drawings, taken in conjunction with the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded perspective view of a hub and disk assembly of a disk drive,
20 including the disk clamp of the present invention;

Figure 2 is an enlarged fragmentary perspective view of the disk clamp;

Figure 3 is a vertical section illustrating the manner in which the clamp secures the disk and associated spacers; and

Figure 4 is a greatly enlarged section of Figure 3.

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DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the drawings and specifically to Figure 1, a disk drive includes a housing H, a chamber C formed in the housing for receiving one or more data disks D including one or more corresponding spacers S. Figure 1 illustrates a single disk D disposed between a pair of spacers S. If no upper spacer were used, the disk clamp would directly contact the disk D. However, it shall be understood that the clamp of the present invention is usable with single or multiple data disks D depending upon the configuration the disk pack.

Now also referring to Figure 3, when the disk drive is assembled, the lower spacer S₁ rests upon a flange 11 of the hub 10. The disk D rests on the lower spacer S₁, and an upper spacer S₂ is placed on top of the disk D. The spring disk clamp 12 contacts the upper surface of the upper spacer S₂. If an upper spacer is not used, the disk clamp would directly contact the disk D. When an external axial load is applied to the clamp 12, retaining ring 14 is inserted into the gap between the concentric groove formed on the upper extension 15 of the hub 10 and the inner surface defining the central opening of the clamp 12, as further discussed below. A balance ring 16 is inserted within a peripheral groove 34 formed on the upper surface of the clamp 12.

Now referring to Figure 2, the specific construction of the spring clamp 12 is best seen. Clamp 12 includes an annular body portion 20. A lower peripheral flange 22 is integral with the body portion 20 and extends radially outward and downward from the lower surface 26 of the clamp 12. The lower peripheral flange 22 terminates at the external 5 peripheral edge 23 of the clamp. The peripheral flange 22 is illustrated as having a flat lower surface; however, as desired, the lower surface of the peripheral flange can be modified to include either a flat or rounded shape. The central opening of the clamp 12 is defined by an inner perpendicular edge 28, and a chamfered or conical angled surface 30. As shown, the most upper portion of the angled surface 30 communicates with the upper surface 32 of the 10 clamp. Finally, the clamp 12 includes the upper concentric groove 34 formed on the upper surface thereof. Groove 34 is located adjacent the peripheral edge 23. An arcuate-shaped pocket 36 of the groove 34 receives the balance ring 16 therein.

Now referring to Figures 3 and 4, the spindle hub 10 includes an annular surface 50 which is provided at a height so that a definable gap exists between it and the lower surface 15 26 of the clamp 12. Because the peripheral flange 22 does not completely cover the upper surface 51 of the upper spacer S₂, the gap extends to the most inner concentric portion 52 of the flange 22.

The upper extension 15 of the hub 10 includes the circumferential groove formed thereon. This groove is defined by one or more shaped surfaces and specifically includes 20 sloping surface 54 and adjacent arcuate surface 56. The sloping surface 54 communicates with a planar annular upper surface 58 of the hub extension 15. The sloping surface 54 and upper surface 58 can be described as forming an annular lip or flange 60.

Once the disk clamp 12 is placed over the hub 10, the axial load is applied on upper surface 32 to set the clamp. In response to the axial loading, the annular body portion 20 deflects downward, thus increasing the gap between surfaces 30 and 54, and narrowing the gap between lower surface 26 and upper surface 50. The clamp primary deflects along the 5 concentric narrowed portion 62 defined between the concentric portion 52 and the inner edge 64 of the groove 34. Therefore, this narrowed portion 62 provides a means for allowing the clamp to deflect in response to a load. When the clamp is deflected, the retaining ring 14 can be positioned between sloping surface 54 and angled surface 30. When the axial load is released, the clamp springs back to achieve its undeflected state; however, the retaining 10 ring 14 prevents full return resulting in the retaining member being wedged between the clamp and the hub. The retaining ring 14 can be sized to accommodate the desired magnitude of the securing force applied for securing the disk pack. Use of a retaining ring 14 having a larger cross sectional area would result in a greater permanent force being applied to the disk pack by the clamp. Preferably, the clamp and hub are constructed so that 15 surfaces 30 and 54 are parallel to one another, as shown in Figure 4, or a positive angle L is defined between the surfaces. The positive angle L between surface 30 and surface 54 is preferably between 0° (parallel) and 15°. A negative angle between the surfaces makes installation of the retaining ring 14 more difficult, while an angle greater than 15° may result in undesirable slippage of the retaining ring.

Because of the variable force which may be applied by the clamp to the disk pack, the clamp is well suited for many disk drive applications. Whether a disk drive includes one or multiple disks, the clamp of this invention eliminates not only the need to use securing

screws, but also eliminates the need to use O-rings or other stabilizing features normally required to prevent radial displacement of the disks with respect to the hub. Contamination is reduced as well because screws are not used to set the clamp.

While the above description and drawings disclose and illustrate a preferred embodiment, this invention is not limited to this specific embodiment. Those skilled in the art to which the invention pertains may make other modifications employing the principles of this invention, particularly upon considering the foregoing disclosure. Therefore, by the appended claims, the applicant intends to cover any modifications and any other embodiments which incorporate the features which constitute essential features of the invention.